CHAPTER 1

The Power of Collaboration

ON DECEMBER 17, 1903, on a bitterly cold windswept beach in North Carolina, five men from the local lifeguard station stood in the sand and watched as Orville Wright took off in his handmade flyer into a twenty-seven-mile-per-hour wind. The twelve-horsepower engine kept him aloft for twelve seconds; he landed 100 feet away from the launch point. Orville and his brother, Wilbur, then took turns in making three more flights, the longest lasting fifty-nine seconds and covering 852 feet. No members of the press witnessed the event; Orville himself mounted his camera on a tripod and asked one of the lifeguards to snap the shutter. The resulting picture is the most famous image of innovation ever taken: The aircraft has just left its track and is 2 feet aloft; Wilbur, standing just off the wing, is leaning back as if astonished at their amazing feat.

How did these two bicycle mechanics from Dayton, Ohio, beat leading scientists, who had fortunes in funding, and win the international race to build the first airplane? The Wrights drew on the power of collaboration: They allowed their innovation to unfold from constant conversation and side-by-side work. Wilbur Wright later explained it this

way: "From the time we were little children my brother Orville and myself lived together, played together, worked together and, in fact, thought together. We usually owned all of our toys in common, talked over our thoughts and aspirations so that nearly everything that was done in our lives has been the result of conversations, suggestions and discussions between us."

The Wrights kept detailed diaries of their transformative collaboration. These diaries show that the Wrights didn't experience a single moment of insight; rather, their collaboration resulted in a string of successive ideas, each spark lighting the next. In 1900, after four years of closely studying everything written on bird flight and glider designs, they took their first trip down to Kitty Hawk. After each practice flight, they modified the glider, and by the end of that first season, they had flown it safely, with several flights of more than 300 feet.

On their second trip to North Carolina in 1901, they realized that the wings weren't providing enough lift to carry the motor the craft would eventually need. Back in Dayton for the winter, they built a wind tunnel that was 6 feet long and, using a powerful fan hooked up to a gasoline engine, tested two hundred wing designs.

On their third trip to Kitty Hawk, in 1902, they were getting so good at flying their glider that they routinely made fifty or more flights each day. But they discovered an unexpected problem, known as "adverse yaw": When warping the wings to steer right or left, the glider lost control and leaned over too far, crashing the wing's tip into the ground (the Wrights called it "well digging"). Before they could fly safely, this problem had to be fixed. First, they added a vertical tail; this helped a bit, but the glider still crashed unpredictably. One day, Orville told Wilbur about a new idea: Modify the vertical tail so that it could be moved by the operator. Wilbur responded by suggesting that the new cable required to control the tail be tied into the wing-warping mechanism so that the operator could work both controls at once. This

collaborative insight proved to be the final piece of the puzzle: By combining wing warping and a movable tail, they had mastered controlled gliding. Now they were ready for powered flight.

In 1903, they designed and built their own gasoline engine and propellers, and then scaled up the aircraft to support the extra weight. They refined the design further by adding a second vertical tail for better control. They arrived in North Carolina for the fourth time in September and worked through October and November fixing tiny problems that kept cropping up. Everything finally came together on that cold day in late December.

Invisible Collaboration

The Wright brothers lived together, ate together, and discussed their project every day. Their collaboration was visible to everyone around them, and it speaks from every page of their journals. But many creative collaborations are almost invisible—and it's these largely unseen and undocumented collaborations that hold the secrets of group genius.

The mountain bike provides a perfect example of what I call "invisible collaboration." No one knows exactly when and where that innovation originated, but it probably dates to the early 1970s in Marin County, California. In the early 1970s, road cycling was making a comeback in America, and Marin County was a cycling hotbed. In the off-season, some of these bicyclists started riding just for fun on the dirt trails of Mount Tamalpais, or Mount Tam as locals call it, which rises 2,571 feet above San Francisco Bay. The roots and rocks would have trashed their expensive road-racing bikes, so they went to yard sales and scrounged up old balloon-tire bikes from the 1930s and 1940s. The fat tires provided a little extra give on the rough terrain. The cyclists found the rush hard to beat as they flew down the trail named Repack

Road at breakneck speed, dropping 1,300 vertical feet in two miles, surrounded by oak and redwood pine trees.

But the old Schwinn frames weren't built for such rugged terrain, and many of them collapsed when they ran into an especially big rock. One trailside tree was dubbed "Vendetti's Face" after a local rider flew headfirst into the trunk. There were other problems, too. The old brakes, used constantly to control speed, would get so hot that the grease evaporated and left a trail of smoke behind each rider. Riders had to pack in new grease after almost every trip down the mountain (thus the trail name "Repack Road"). And because the old bikes didn't have shifters or gears, riding uphill was almost impossible.

On December 1, 1974, three riders from Cupertino, seventy-five miles to the south, showed up in Marin for an off-road race. They called themselves the Morrow Dirt Club. They were riding old balloon-tire bikes, but these machines were different: They'd been rigged up with shifters and multiple gears, and the handlebars were modified into today's familiar "longhorn" shape, providing better control. The Marin bikers had never seen anything like it before, and they quickly modified their own bikes with the new ideas. At about the same time, a third group of fat-tire riders had formed in Crested Butte, Colorado, a desirable location for scenic, rugged rides, such as the Pearl Pass road from Crested Butte to Aspen. A few years later, when five riders from Marin took their shifter-modified bikes to the Pearl Pass race, they not only left the local riders in the dust but also left behind their new ideas.

By the late 1970s, some of the more mechanically inclined riders were starting to make a living building custom mountain bikes, and business grew by word of mouth. When Gary Fisher and Charlie Kelly launched the first mountain bike company in 1979, they sold hand-made bikes costing $1,400. Even at that high price, buyers snatched them up. Within a few years, the big bike companies entered the business, and by 1986, mountain bike sales surpassed road bike sales. Ten

years earlier, only a few hundred people had even heard of mountain biking; ten years later, in 1996, mountain biking was an Olympic sport.

The early riders in California and Colorado weren't trying to change biking forever and they weren't trying to start a new industry; they were just having fun. But then unexpected events followed their initial innovations. The Morrow Dirt Club designed the gear-shifter and the new handlebars; the Marin County riders devised brakes that wouldn't burn out; and several riders independently designed custom-made frames that wouldn't break on the big bumps. After that, still others created manufacturing techniques and marketing strategies, and gradually they modified the bike to appeal to mainstream America. Soon, all of us—buyers, riders, and commuters—did the rest. The mountain bike was the result of a largely invisible long-term collaboration that stretched from Marin to Colorado.

Although the Wright brothers will always hold a special place in history, today's airplanes also unfolded through invisible collaboration. The Wrights' most significant idea, to steer using wing warping and a moving vertical tail, was soon replaced by other aviators with a better invention: the aileron, a separate surface on the trailing edge of the wing that pivoted up and down. By the beginning of World War I, most of the Wrights' ideas had been replaced by better technologies.

We're drawn to the image of the lone genius whose mystical moment of insight changes the world. But the lone genius is a myth; instead, it's group genius that generates breakthrough innovation. When we collaborate, creativity unfolds across people; the sparks fly faster, and the whole is greater than the sum of its parts.

Collaboration drives creativity because innovation always emerges from a series of sparks—never a single flash of insight. The Wright brothers had lots of small ideas, each critical to the success of the first powered flight. The mountain bike wasn't commercially viable until many distinct

ideas came together. These two stories show how the genius of the group emerges through the sanding and polishing of raw innovation.

Jazz Freddy

When scientists first began looking at creativity in the 1950s, they focused on the solitary creative person. Although this research provided important insights—for example, creative people are slightly above average in intelligence but aren't necessarily geniuses, and creative people are good at generating lots of ideas—by the early 1990s, those of us studying creativity had reached the limits of this approach. We were beginning to see that even the best creativity tests couldn't predict which children would become the most creative adults. Even the most enriched elementary school curricula seemed to have no significant impact on how creative students would be years later. My colleagues and I realized that we needed to find a new way to explain how innovation takes place and how to unleash each person's creative potential.

Psychologists are typically trained to focus on the individual, an approach firmly supported by our culture's belief that the solitary individual is the source of creativity. But to our surprise, beginning in the 1990s, our research began to point in the opposite direction. We began to see that innovations once believed to be the creation of a genius actually emerged from invisible collaborations, and that collaboration was responsible for famous creations throughout history.

Sigmund Freud is credited with creating psychoanalysis, but in fact these ideas emerged from a vast network of colleagues. The French impressionist painting associated with Claude Monet and Auguste Renoir emerged from a closely connected group of Parisian painters. Albert Einstein's contributions to modern physics were embedded in an international collaboration among many laboratories and many teams. Psychoanalysis, impressionism, and quantum physics emerged

over many years of interactions, trial and error, and false starts—not in a single burst of insight.

As we moved beyond historical observation to the laboratory and to the everyday world, a new science of creativity began to form. My contribution has been to map the architecture of collaboration in two uniquely creative groups: the improvising ensembles of jazz and theater. These are the purest form of group genius; their creative performances emerge from everyone's equal participation.

In 1992, early in my research, I began to hear about an improvisational theater group called Jazz Freddy, which was performing at the Live Bait Theater in Wrigleyville—an urban neighborhood on the North Side of Chicago named for its central feature, the Chicago Cubs' Wrigley Field. The ten-member cast of Jazz Freddy chose the name to emphasize their links with jazz—their improvisations were free-flowing and unpredictable. I'd heard that the Live Bait had been sold out for every Jazz Freddy performance—pretty good for a type of theater that was off most people's radar at that time.

What made Jazz Freddy unique? After all, Chicago was the birthplace of modern improv theater, the city where the Compass Players and the Second City Theater created improv in the 1950s. By the early 1960s, Chicago improv was nationally known; it produced stars such as Mike Nichols and Elaine May as well as the legendary television program *Saturday Night Live,* which revolutionized small-screen comedy.

Through the 1980s, *Saturday Night Live* kept going strong. But back in Chicago, the improv scene had fallen into a rut. The famous Second City Theater had stopped improvising on stage, preferring instead to stick with scripted sketch comedy. Improv was risky; scripts were better at drawing in the large paying audiences of tourists who basically just wanted to see *Saturday Night Live,* live. It was a well-known secret among Chicago actors that during the break the cast worked furiously to weave the audience suggestions into the scripted material they were developing for the next season's show. Second City was undeniably

funny and successful, but it didn't have the exciting edge that early improv had enjoyed.

Jazz Freddy was bringing back the excitement by doing something more radical, more free-form than Second City's sketch comedy. Jazz Freddy's goal was riskier than anything that had been tried before: Every night, they performed a fully improvised one-hour play in two acts, separated by an intermission.

On a Saturday night in April 1993, I made the forty-minute drive to Wrigleyville from my home at the University of Chicago. The rumors that I'd heard were true—the Live Bait was packed. I sat in a folding chair in the aisle about two feet from the stage, which was only a foot high, and barren except for ten wooden chairs. Right on schedule, the lights came up; the audience applauded as the cast members ran onto the stage and stood in an informal group facing the audience. Two cast members stepped to the front of the stage and asked the audience to supply an event and a location. "The Olympics," shouted one member of the audience. "A convent," yelled another.

The lights went down; in the dim glow cast by the aisle safety lights, we could see the ten cast members walking to the sides of the stage to sit in the wooden chairs. Two of the actors almost simultaneously decided to walk to the center of the stage; one of them, noticing that the other had started first, deferred and went back to his chair at stage left. The first actor, John, pulled a chair to the center of the stage and sat down, facing the audience, as the stage lights came up. He mimed working at a desk—he took a cap off of a pen, opened a book, and started to make underlining motions as he studied the page. He stopped to rub his eyes. He then turned the page and underlined some more. The other actors watched intently from the sides of the stage; the audience was completely quiet. After about twenty seconds, Mary stood up at the opposite side of the stage, and walked over to John, miming the act of carrying something in both hands held in front of her:

MARY: Here are those papers.
(*Mimes putting down the "papers" and remains standing. 2 second pause.*)
JOHN: Thanks.
(*Looks up to face* MARY. *2 second pause.*)
I really appreciate your doing those copies for me.

(BILL *approaches from stage left, also carrying "papers," and stops next to* MARY.)

BILL: Here are those papers.
(*Puts down the papers.*)
JOHN: Thanks a lot,
(*Still facing the two*)
you guys have really been great.
(*2 second pause*)
I'm gonna stop booking for now.
(*Closes book on desk.*)
MARY: Okay.
BILL: Sure.
(*1 second pause*)
I'm gonna go get some more papers.
JOHN: Alright.
(*He stands up. 1 second pause*)
Thanks a lot, I appreciate it.
BILL: You're welcome.
(*1 second pause*)
We mean it.
(*As he says this,* BILL *touches* MARY's *arm;* MARY *reaches up her other hand to grasp his hand; they stand holding hands.*)
JOHN: Thanks for being in my corner.
BILL: We always will be.

Even these first thirty seconds of the one-hour performance demonstrate the key characteristics of improvisation. It's unpredictable; the actors don't even know who's going to speak next, much less what

they're going to say. Even an offstage actor can walk on and take the next turn, as Bill does when he carries in more papers. The actors leave unusually long pauses between their turns of dialogue because they're just getting into the flow of the performance. And they choose ambiguous lines that open up possibilities.

After about ten minutes, the basic elements of the plot began to emerge, and the pace accelerated. By the intermission, Jazz Freddy had created two independent plotlines. The Olympics plot was about a baseball team training for the Olympics, and John has become an umpire who isn't very good and probably needs glasses. In the convent plot, the nuns are playing cards and spray-painting graffiti on the religious murals. One of the nuns has discovered that she's turned on by the janitor's boot fetish. The final scene in the first act takes place in heaven. God confers with Jesus and Saint Peter as they try to decide the best way to right things at the convent.

In the second act, the actors managed to weave these two plots together. The baseball games get ugly as the team members become filled with hatred for their opponents. Hoping to return the nuns to the straight and narrow, God sends Saint Peter to the convent disguised as a young girl. The play ends with several of the female baseball players quitting the sport to join the convent.

How can ten people go on stage and create such a complex and entertaining performance when they have absolutely no idea about what's going to happen? This is the question that I set out to answer. Armed with my video camera, I visited improv theaters all over Chicago; I ended up with a bookshelf full of videotapes—some of "long form" groups like Jazz Freddy, others of more traditional groups that did short skits and games. Then, back in the lab, I spent years analyzing the dialogues second by second, and I gradually began to understand how the performances emerged from the creative power of collaboration.

Inside the Black Box

It's not news to anyone in the corporate world that collaboration is powerful. Businesses everywhere are moving to team organizations, distributed leadership, and collaboration. The trend is so strong that even office furniture companies have been rethinking the cubicle-and-desk paradigm. James P. Hackett, chief executive officer of Steelcase, is leading the company in designing a new kind of furniture that will support group collaboration. Robyn Waters, Target's former vice president of trend, design, and product development, says that "collaboration is Target's secret sauce." Whole Foods Market attributes its success to its use of self-managed teams, which it calls the "Whole People" philosophy.

But the managers who have embraced the power of collaboration have largely taken a black-box approach: They look at overall team characteristics—such as members' personality traits—instead of investigating what goes on inside the box. My research strongly suggests that the secret to understanding what makes a collaboration successful lies inside the box, in moment-to-moment interactional dynamics.

Since the early 1990s, my colleagues and I have been using a variety of approaches to open up the black box of collaboration, to discover what happens when collaboration translates each person's creativity into group genius. My preferred approach is called *interaction analysis,* a time-consuming method of analyzing verbal gestures, body language, and conversation during collaboration. It requires about an hour of analysis for every minute of videotape to fully understand what's going on. I performed with many jazz and theater groups in the early 1990s, and because I was one of the group, they didn't mind when I set up my video camera and tripod. After two years of performing and collecting videotapes, I spent the next ten analyzing these collaborations, line by line and second by second. What I learned surprised me, and it changed the way I think about innovation.

In both an improv group and a successful work team, the members play off one another, each person's contributions providing the spark for the next. Together, the improvisational team creates a novel emergent product, one that's more responsive to the changing environment and better than what anyone could have developed alone. Improvisational teams are the building blocks of innovative organizations, and organizations that can successfully build improvisational teams will be more likely to innovate effectively.

On the basis of my research, I've identified seven key characteristics of effective creative teams.

1. Innovation Emerges over Time

No single actor comes up with the big picture, the whole plot. The play emerges bit by bit. Each actor, in each line of dialogue, contributes a small idea. In theater, we can see this process on stage; but with an innovative team, outsiders never see the long chain of small, incremental ideas that lead to the final innovation. Without scientific analysis, the collaboration remains invisible. Successful innovations happen when organizations combine just the right ideas in just the right structure.

2. Successful Collaborative Teams Practice Deep Listening

Trained improv actors listen for the new ideas that the other actors offer in their improvised lines, at the same time that they're coming up with their own ideas. This difficult balancing act is essential to group genius. Most people spend too much time planning their own actions and not enough time listening and observing others.

3. Team Members Build on Their Collaborators' Ideas

When teams practice deep listening, each new idea is an extension of the ideas that have come before. The Wright brothers couldn't have thought of a moving vertical tail until after they discovered adverse yaw, and that discovery emerged from their experiments with wing warping.

Although a single person may get credit for a specific idea, it's hard to imagine that person having that idea apart from the hard work, in close quarters, of a dedicated team of like-minded individuals. Russ Mahon—one of the Morrow Dirt Club bikers from Cupertino—usually gets credit for putting the first derailleur on a fat-tired bike, but all ten members of the club played a role.

4. Only Afterwards Does the Meaning of Each Idea Become Clear

Even a single idea can't be attributed to one person because ideas don't take on their full importance until they're taken up, reinterpreted, and applied by others. At the beginning of Jazz Freddy's performance, we don't know what John is doing: Is he studying for a test? Is he balancing the books of a criminal organization? Although he was the first actor to think of "studying," the others decided that he would be a struggling umpire, a man stubbornly refusing to admit that he needed glasses. Individual creative actions take on meaning only later, after they are woven into other ideas, created by other actors. In a creative collaboration, each person acts without knowing what his or her action means. Participants are willing to allow other people to give their action meaning by building on it later.

5. Surprising Questions Emerge

The most transformative creativity results when a group either thinks of a new way to frame a problem or finds a new problem that no one had noticed before. When teams work this way, ideas are often transformed into questions and problems. That's critical, because creativity researchers have discovered that the most creative groups are good at finding new problems rather than simply solving old ones.

6. Innovation Is Inefficient

In improvisation, actors have no time to evaluate new ideas before they speak. But without evaluation, how can they make sure it'll be good? Improvised innovation makes more mistakes, and has as many misses as hits. But the hits can be phenomenal; they'll make up for the inefficiency and the failures.

After the full hourlong Jazz Freddy performance, we never do learn why Bill and Mary are making copies for John—that idea doesn't go anywhere. In the second act, a brief subplot in which two actors are in the witness protection program also is never developed. Some ideas are just bad ideas; some of them are good in themselves, but the other ideas that would be necessary to turn them into an innovation just haven't happened yet. In a sixty-minute improvisation, many ideas are proposed that are never used. When we look at an innovation after the fact, all we remember is the chain of good ideas that made it into the innovation; we don't notice the many dead ends.

7. Innovation Emerges from the Bottom Up

Improvisational performances are *self-organizing*. With no director and no script, the performance emerges from the joint actions of the actors.

In the same way, the most innovative teams are those that can restructure themselves in response to unexpected shifts in the environment; they don't need a strong leader to tell them what to do. Moreover, they tend to form spontaneously; when like-minded people find each other, a group emerges.

The improvisational collaboration of the entire group translates moments of individual creativity into group innovation. Allowing the space for this self-organizing emergence to occur is difficult for many managers because the outcome is not controlled by the management team's agenda and is therefore less predictable. Most business executives like to start with the big picture and then work out the details. In improvisational innovation, teams start with the details and then work up to the big picture. It's riskier and less efficient, but when a successful innovation emerges, it's often so surprising and imaginative that no single individual could have thought of it.

Elixir

Today's most innovative companies are the ones that have successfully implemented the improvisational approach—from the award-winning Silicon Valley design firm IDEO to the manufacturing company W. L. Gore & Associates, tucked away in the countryside along the Delaware-Maryland border.

IDEO has contributed to more than three thousand products in at least forty industries, including Crest toothpaste tubes, toothbrushes, the original Apple computer mouse, an electric guitar, bike helmets, telephones, furniture, fishing equipment, and Nike sunglasses. IDEO succeeds because it has mastered improvisation—beginning with the classic collaboration technique known as brainstorming, which is designed so that each person's sparks of insight can be immediately built

on by others. IDEO uses rapid prototyping so that shared ideas can prompt later ones. The company creates multiple teams to work on the same project independently so that different insights can cross-fertilize and blend; this strategy results in inefficient redundancies, and team members expect frequent failures. Employees aren't assigned to teams; each team forms spontaneously and then splits up when its task is done.

But a company doesn't have to be a trendy design firm to benefit from improvisational collaboration. In December 2004, *Fast Company* magazine went searching for the most innovative company in America—and they found W. L. Gore & Associates, maker of the famous GORE-TEX waterproof material. Most people don't know that Gore has created more than a thousand products—from Elixir, the top-selling acoustic guitar string, to Glide dental floss, to medical products such as heart patches and synthetic blood vessels.

Gore has succeeded by tapping into the power of collaboration. Bill Gore, the founder, created the company with hardly any hierarchy, few ranks and titles, and a minimum of structure, aside from such necessary support functions as human resources and IT. He organized the company into small task forces that constantly self-organize and regroup in response to changing needs. These self-managed teams don't have clear-cut roles and responsibilities: "Your team is your boss, because you don't want to let them down," one employee said. "Everyone's your boss, and no one's your boss." Teams form and manage themselves improvisationally, and employees define their own roles in the company improvisationally.

All employees reserve 10 percent of their time to pursue speculative new ideas (a practice also followed at innovation powerhouses such as 3M and Google). Ad-hoc teams form around these off-the-record ideas and operate for years before a new product is revealed to top management. The Elixir guitar strings started with a group of three employees who realized that the technology used in Gore's brand of Ride-On bike

cables could be transferred to guitar strings. The Ride-On cables were coated with a thin film of plastic so that they'd slide through the cable housing with less friction; these engineers realized that by putting a similar coating on guitar strings they could prevent the dulling of sound that occurs when natural oils from the fingers corrode the strings. These three worked on the idea for 10 percent of their hours each week; once the idea had taken shape from this initial collaboration, they gradually persuaded six other colleagues to contribute their expertise. After three years of working without permission or oversight, the team was ready to start working on the project full-time, and they sought out the official support of the company. Soon after its release in 1997, Elixir quickly became the top-selling acoustic guitar string—a success that emerged from improvised innovation.

What do successful collaborations look like? Where do the most innovative ideas come from? Gore isn't unique; it turns out that the most innovative ideas emerge spontaneously, from the bottom up. To learn why, let's turn to the next chapter, where we'll examine the many different faces of improvised innovation.

CHAPTER 4

From Groupthink to Group Genius

THE TERM "BRAINSTORMING" is so widely used that it's easy to forget it was coined only in the 1950s by Alex Osborn, a founding partner of the legendary advertising firm BBDO. Osborn's key idea was that the critical voice is the enemy of creativity; during a brainstorming session, ideas are kept flowing and critical analysis is put off for later. In the 1950s, Osborn funded the Creative Education Foundation at the University of Buffalo to teach his theory of "creative problem solving"; more than fifty years later, the annual Creative Problem Solving Institute is still going strong, and brainstorming is still practiced by corporations in every industry.

In a series of best-selling advice books, Osborn laid out the basic principles of brainstorming still in use today. First, no criticism: Don't evaluate any ideas until you've finished generating them. Second, "freewheeling" is welcomed; the wilder the idea, the better. Third,

quantity is the goal; the more ideas you think up, the more likely you are to find the best ideas. Fourth, look for combinations of previous ideas, and for improvements on previous ideas.

IDEO has carried the banner of brainstorming more than any other company in recent years. Between 5 and 10 percent of each designer's time is devoted to brainstorming. IDEO has added a few rules to Osborn's original four: Stay focused on topic, stick to one conversation at a time, be visual, be physical, and use the space (white boards surround each room and Post-it notes are everywhere). To bring in ideas from employees who aren't team members, an IDEO brainstorm is scheduled in advance. A trained facilitator begins the planning by developing a list of potential participants; the goal is to make sure that all the necessary skills are represented in the group. Topics range from targeted, problem-solving tasks—"This tool is too noisy"—to vague, problem-finding tasks, such as "What can a computer be used for when it is off?" They last between forty-five minutes and two hours, and have between three and ten participants.

IDEO has special conference rooms designed for brainstorms; the brainstorming rules are displayed on signs around the room. Everyone gets butcher paper and pens. During the brainstorm, the facilitator enforces the rules and writes everyone's suggestions on the white board. Using a trained facilitator is essential to good brainstorming; research shows that groups led by a trained facilitator are twice as creative.

Brainstorming is the most popular creativity technique of all time. There's just one problem: It doesn't work as advertised. For every success story like IDEO's, you can find another company for which brainstorming has failed to deliver on its potential. This isn't surprising to psychologists; decades of research have consistently shown that brainstorming groups think of far fewer ideas than the same number of people who work alone and later pool their ideas.

The Perils of Design by Committee

We've all been in meetings that don't go anywhere. The wry phrase "design by committee" doesn't refer to group genius—Sir Alec Issigonis, the British designer of the original Mini car, used to say that a camel is a horse designed by a committee. The phrase captures a sad fact of life: In many organizations, the group ends up being dumber than the individual members. How do we make sure we have a genius group and not a stupid group? Fortunately, decades of research have shown us why brainstorming fails, and we can use this research to avoid the pitfalls of design by committee.

The first study of Osborn's technique was done at Yale University in 1958. Three psychologists recruited forty-eight people and put them into twelve four-man groups. They gave them Osborn's four basic rules of brainstorming, and then gave them twelve minutes each on three problems. Then for comparison, they recruited forty-eight more people to work alone on the same problems, for the same amount of time; the solo workers were also given Osborn's brainstorming rules. After the forty-eight solitary subjects had finished their tasks, the researchers randomly assigned them to twelve "groups" of four. The researchers chose to call these *nominal groups*.

The result surprised everyone: The nominal groups had generated almost twice as many ideas, for all three problems, as the brainstorming groups! The researchers then examined which groups had more original ideas—defined as any idea that came from one group or one person. Brainstorming lost again: The nominal groups generated about twice as many original ideas as the real groups. Finally, the researchers evaluated the quality of each idea by asking independent judges to rate all the ideas on three measures: feasibility, effectiveness, and generality. The nominal group had twice as many good ideas. The final score: nominal groups, 3; brainstorming groups, 0.

But just because nominal groups are more creative doesn't mean that the rules of brainstorming don't work—after all, the solo individuals were also using those rules. These studies just show that the rules work better when people use them alone than when they use them in groups. Several studies have shown that people who'd been through brainstorming training later had more ideas when they worked alone.

Researchers next looked for idea-generating rules that would work even better than Osborn's. They told their subjects: "The more *imaginative* or *creative* your ideas, the *higher* your score will be. Each idea will be scored in terms of (1) how *unique* or different it is—how much it differs from the common use and (2) how *valuable* it is—either socially, artistically, economically, etc." These instructions are very different from those given for classic brainstorming because people are being told to use specific directions in judging which ideas they come up with. Groups working with these instructions have fewer ideas than brainstorming groups, but they have more *good* ideas. What's most important is being explicitly told to be imaginative, unique, and valuable; then, it's okay if your critical faculties are still engaged. Osborn had one thing right: Most people use the wrong criteria to evaluate their ideas; they think about what will work, about what worked before, or about what is familiar to them.

This discovery—that when subjects are told they'll be evaluated for creativity, they're more creative than when they're told not to use any criteria at all—has been reproduced repeatedly in the laboratory. When groups are asked to suggest good, creative solutions, they have fewer ideas but those ideas are better than those generated by groups using the brainstorming rules. IDEO's brainstorming sessions are successful because their designers are implicitly guided by a drive to be creative and original, and because the sessions always conclude with a

period of critical evaluation as the members of the group vote on their favorite ideas. The real challenge to creativity isn't only quantity; many managers are fond of saying that "ideas are cheap." Just as important is that, eventually, someone has to pick the best ideas, and that is accomplished by choosing for a combination of uniqueness and value.

An ingenious study at Purdue University in 1961 underscored the value of selection. The researchers asked students to invent brand names for three new products: a deodorant, an automobile, and a cigar. Half the groups were given the usual noncritical brainstorming instructions; the other half were given critical instructions: "No idea is ever worth anything unless it has been well thought out. . . . We want good, practical ideas. Let's try to avoid stupid or silly ones . . . the emphasis is on quality not on quantity." All the brand names were then judged by fifty other students as a measure of idea quality.

The noncritical groups generated about twice as many ideas as the critical groups, just as Osborn would have predicted. But the increase turned out to be an increase in *bad* ideas; both groups had about the same number of highly rated ideas, meaning that the critical group had a higher proportion of good ideas. In the real world, someone later has to evaluate the ideas and pick the good ones; that task would be more time-consuming for the longer list generated by the brainstorming group, and the end result would be the same number of good ideas anyway. Because there are more bad ideas to sift through with brainstorming, it's better to give the group members critical instructions because not only will they come up with just as many good ideas but they'll save others the work of weeding out more bad ideas later.

In addition to using groups to generate ideas, we should be using them to evaluate ideas. And that's another task where group genius wins out—it turns out that groups are better at evaluating ideas than a nominal group of solitary individuals.

Fixing Brainstorming

By about 1970, it was pretty clear that brainstorming wasn't supported by the research. Still, so many people were convinced that it was effective that researchers kept comparing real and nominal groups into the late 1970s, varying the situation a little bit each time; and every study confirmed the original 1958 findings. Although most of the studies were conducted in the lab, nominal groups have more and better ideas even when brainstorming is studied in a real company. For example, one study looked at a company that had a strong team culture; every employee had as many as three days of training in group dynamics, and trained facilitators led the groups. Existing company work teams were asked to generate ideas about ways their company could be improved. Even in this team-focused culture, nominal groups averaged twice as many ideas.

By the 1980s, even the skeptics were convinced: The original brainstorming design simply didn't work at generating the most original new ideas. But brainstorming groups are good at evaluating ideas, and they can be made more effective by altering the instructions (as IDEO has done). In the last few decades, psychologists have discovered how to reconfigure groups to make them maximally creative. They began by studying what was causing the productivity loss in brainstorming groups; if they could find out why brainstorming groups were less effective, they reasoned, then maybe they could show groups how to realize their full potential.

Researchers soon identified three possible reasons why brainstorming groups were less creative, and each cause suggests techniques to enhance group creativity. The first is *production blocking*. Group members have to listen closely to other people's ideas, which leaves individual members with less mental energy to think of new ideas. Also, individuals might be distracted from their own ideas by the flurry of idea generation around them. This is why productivity loss is greater

with larger groups: Each person has less time to talk as the number of group members goes up.

One cause of production blocking is *topic fixation*—research shows that ideas in brainstorming groups tend to cluster in a few categories, which is less true of nominal groups. When compared with solo brainstormers, groups become fixated faster and stay in the same category for longer. The way to prevent topic fixation is by giving group members time periods to work alone, alternating with group interaction. For example, *electronic brainstorming*—where ideas are typed by each group member into a shared computer screen like a chat room—results in more creativity because topic fixation is reduced, and *brainwriting*—in which each member of the group takes five minutes to write out his or her ideas alone and then passes the list to the next person—is also much more effective than standard brainstorming. Electronic brainstorming and brainwriting groups both have just as many ideas as nominal groups.

Social inhibition is a second cause of productivity loss. This is when a group member holds back an idea for fear of what the others will think. When people are asked to brainstorm on a controversial political topic (such as how to reduce the number of immigrants in the country), they have fewer ideas than those who brainstorm about a noncontroversial topic (such as how life in the suburbs can be improved). And the same is true when there's an authority figure or an expert in the group, or when subjects are told that experts are watching and listening to them through a one-way mirror. If the boss is sitting in with the group, members are likely to be more worried about what he or she thinks than what their peers think. To reduce the negative effects of social inhibition, the first step is to make sure that the members of the group feel truly equal and that no authoritarian figure is present—one of the conditions of group flow. At IDEO, when Tom Kelley, the general manager, joins a brainstorming group, he defers to the group facilitator and follows the same rules as the other participants. A

second technique for reducing social inhibition is to use a trained facilitator to draw people out and to note who is holding back.

Social loafing is a third cause of productivity loss. When people are in a group they don't feel as accountable for the outcome as they do when they're working alone; the responsibility is distributed among the group members, so individuals relax a little and perhaps don't work as hard. In brainstorming groups, no one keeps track of who thought of each idea. In laboratory studies, groups that expect each member to be assessed separately come up with more and better ideas.

Groupthink

If brainstorming isn't the creativity panacea some people have thought it to be, why does its popularity persist? It's because of the *illusion of group effectiveness.* When researchers ask group members whether they think their groups performed better than they did on the same task alone, they always say that the group helped them—even though the researchers have hard numbers that prove otherwise. When I create nominal groups in my workshops, they're always more productive than the brainstorming groups, just as the research predicts. But the people in the solitary condition find it boring to list ideas alone, whereas the brainstorming groups enjoy high-energy conversation and laughter. Having a good time makes people see the group as more effective than it really is.

A famous 1972 book by Irving Janis coined the term *groupthink* to describe those all-too-common situations where a team of smart people ends up doing something dumber than they would have done if they had been working on their own. Janis told a story about a group of twelve smokers who were brought together by a health clinic to help them reduce their smoking. At their second meeting, two of the most dominant members argued that heavy smoking was an almost incurable

addiction. The majority of the others soon agreed that no smoker could be expected to cut down very much. But one heavy smoker, a middle-aged executive, disagreed; in fact, he said, by using willpower he'd stopped smoking completely since joining the group. The other eleven ganged up on him so fiercely that at the beginning of the next meeting, he announced, "I have gone back to smoking two packs a day and I will not make any effort to stop smoking again until after the last meeting." The other members of the group gave him a round of applause. Keep in mind that the whole point of the group was to reduce smoking!

The more esprit de corps in the group, the greater the likelihood that groupthink will result in bad decisions. When group cohesiveness is high, everyone gets along; they like each other and like being in the group. The group begins to share a little too much tacit knowledge; if a member challenges the others, he or she is ganged up on—just as the man who quit smoking was. The paradoxical finding is that even though everyone thinks collaboration is wonderful, only certain groups benefit from its power.

From Additive to Improvised Collaboration

How can we reconcile these studies of brainstorming and groupthink with the research that we've seen so far showing the power of collaboration? Perhaps the biggest problem with brainstorming studies is the simple fact that the tasks assigned to the group—coming up with a list of ideas or solutions—could, in theory, be performed by individuals. The creative activity of each person is *additive:* You can just add up the individuals to create a nominal group measure. But the most innovative groups engage in tasks that aren't additive.

Improvising groups are different from work teams that are brought together simply because there's too much work for one person, or

because people equipped with different skill sets are needed. In those teams, a manager divides the labor and assigns the tasks. But with improvising teams, the set of subtasks isn't known at the beginning; the distribution of work emerges later. Some subtasks can never be broken up because they require the efforts of multiple team members. Division-of-labor teams aren't likely to generate true innovation, and even if they have status meetings once a week, innovations will rarely emerge.

In improvised innovation, a collective product emerges that could not even in theory be created by an individual. Think of a four-person jazz group as it improvises. Now, try to imagine a separate drummer, bassist, pianist, and saxophone player, each playing the same song but in separate rooms and unable to hear each other—this would be the nominal group. Imagine then using a recording studio to overlay their four performances to create a single recording; it would sound horrible. At every musical moment, there would be tiny but noticeable failures to sync up, and the "nominal band" could never get into a groove. The real jazz group would win, hands down. The creativity in improvised innovation isn't additive; it's exponential.

In brainstorming groups, one person's comment might inspire someone else to think of a new idea; but if the first person had been given enough time, he or she might have thought of that same idea. In a jazz group, there are so many different performance styles that no performer is capable of playing every phrase or rhythm. Jazz musicians play the same songs hundreds of times over the course of a career, and each time they play something new. Anyone asked to brainstorm "brand names for a deodorant" every Monday for a year would be hard-pressed to think of something new after the first few weeks. In group genius, the search space of possible solutions is much greater and much more complexly structured than the simple lists that are generated in lab studies. Groups need to be designed for genius, with the insights

provided by the science of collaborative creativity—and science has come a long way since Osborn's cold-war fad.

Collaboration and Complexity

Up to now we've been talking about verbal creativity: coming up with words or sentences. What happens when a team's task is to develop something concrete or visual? IDEO, being a design firm, creates objects that have to look great, and their brainstorming rules include "be visual," "get physical," and "the space remembers." With visual creativity, researchers have found that groups beat out solo workers—a finding that group researchers did not discover until recently. Dan Schwartz, a Stanford psychologist, compared solitary problem solving with pairs solving the same problems. For example, Schwartz asked students to solve eight problems about gears that were all like this description except that the number of gears was different:

> Five meshing gears are arranged in a horizontal line much like a row of quarters on a table. If you turn the gear on the furthest left clockwise, what will the gear on the furthest right do?

Previous research has shown that individuals and groups can solve these problems easily. Both individuals and groups start out by twisting their hands in the air to simulate gear movement. But Schwartz discovered that in the process of solving eight gear problems, the collaborative pairs often discovered an underlying rule: If the gears add up to an odd number, the first and last gear will turn in the same direction (this is called the *abstract parity rule*). Once the pair discovered this rule, they stopped motioning with their hands and were able to solve the eighth and final problem, with 131 gears, in about one-tenth of the time.

Only 14 percent of the solo workers discovered the rule, but 58 percent of the pairs did: four times as many. Even if two of the individuals were pooled into a "nominal pair," mathematically they would be expected to discover the rule only 26 percent of the time. Because the pairs had to communicate to solve the problems, they developed collaborative representations that neither would have alone, and those representations had to be more abstract to accommodate the two perspectives that each student started out with.

These problems are very different from classic brainstorming, with its goal of generating long lists of ideas. First, the problem was something the students had never done before, so they didn't yet know how to talk about it. Second, all three tasks could be represented visually. Third, each task involved many different components and the task could be solved only by understanding the relations between those components.

Many innovations depend on visualization, abstract representation, and complex relations. Scientists often think about complex theories in visual and spatial ways; Albert Einstein solved advanced problems in physics by envisioning falling elevators and passing trains. And, of course, artistic endeavors such as painting and sculpture are deeply visual. Groups do worse at additive tasks, such as coming up with simple lists of ideas, but they often work better for the complexity of the real world—where new ideas are complex combinations of prior ideas, where the task is new and unfamiliar to the group members, and where new ideas often depend on visualization and abstraction.

Why Diversity Works

In the last chapter, we learned that before a group can move into flow, the members have to share tacit knowledge and demonstrate comparable skill levels. But we also learned that if the group members are too

familiar with each other, interaction is no longer challenging, and group flow fades away. Only by introducing diversity can we avoid the groupthink that results from too much conformity.

A long research tradition shows that when solving complex, nonroutine problems, groups are more effective when they're composed of people who have a variety of skills, knowledge, and perspective. Homogenous groups might work well if everything stays pretty much the same; they might even be more efficient. But the cost of short-term efficiency is eventual failure when the environment changes and innovation is required. For example, one study found that the most innovative banks—the ones that came up with the most new products and services—were led by teams that combined a wide range of expertise.

Diversity makes teams more creative because the friction that results from multiple opinions drives the team to more original and more complex work. As John Seely Brown, the legendary former head of Xerox PARC, puts it: "If you talk to film directors, you hear that the collision of ideas happens all the time in the filmmaking. . . . The breakthroughs often appear in the white space between crafts. . . . These crafts start to collide and in that collision radically new things start to happen." Conflict keeps the group from falling into the groupthink trap. But conflict is difficult to manage productively because it can easily spiral into destructive interpersonal attacks that interfere with creativity. Diversity enhances performance only when the group flow factors are present, including some degree of shared knowledge; a culture of close listening and open communication; a focus on well-defined goals; autonomy, fairness, and equal participation.

The most surprising creative insights always result from connections among different bodies of knowledge—this is the thesis of Frans Johanssen's book *The Medici Effect.* Says Paul Saffo, at the Institute for the Future, "An advance in a single field never triggers substantial change. Change is triggered by the cross impact of things operating together." The reason groups are so effective at generating innovation is

that they bring together far more concepts and bodies of knowledge than any one person can. Group genius can happen only if the brains in the team don't contain all the same stuff.

Rewarding Group Genius

When groups work closely together, how do we know who's responsible for good work and good ideas? Who should be given the big raises and the promotions? If the members of the team know that their individual contributions can't be measured, there's always the risk of social loafing: Someone might sit back and let everyone else do the work. But rewarding each individual can easily interfere with the collaborative dynamic of the team. So what's a company to do?

Ruth Wageman spent four months studying more than eight hundred service technicians in 152 groups at Xerox Corporation. One-third of the groups had assignments that needed only one technician to solve, one-third worked on more complex tasks that required teamwork to solve, and one-third worked on assignments that required some solitary work and some teamwork. Wageman then manipulated the incentive structure: manager feedback on how well they were performing, merit pay increases, profit sharing. Sixty of the groups got group rewards, fifty-five got individual rewards, and seventy-seven got a hybrid combination of both.

The group reward condition resulted most consistently in high performance, although individual rewards worked just as well for the teams that were assigned solitary tasks. But when the task required teamwork, the group rewards resulted in the highest effectiveness. High levels of task interdependence, such as a basketball team, result in more communication, helping, and information sharing than solitary tasks. And there's no evidence of social loafing in interdependent teams—that's been observed only in temporary laboratory teams. Interdependent teams benefit the most from group rewards. These are also the teams that enter group flow and generate maximum innovation.

My research reveals the creative power of collaboration. But for well over a century, there's been an opposing belief that groups make people dumber. When the French sociologist Gustave Le Bon wrote an influential book about groups in the nineteenth century, he focused on mobs, riots, and panics. Janis's studies of groupthink remind us that there's always a potential dark side to collaboration.

Putting people into groups isn't a magical dust that makes everyone more creative. It has to be the right kind of group, and the group has to match the nature of the task. If the goal is creativity and innovation, then we can draw on the studies of this chapter to add a few more rules to the ten features of group flow:

- Don't use groups for additive tasks—tasks that people could do separately and then sum up. Instead, use them for complex and improvisational tasks.
- Keep groups to the minimum number of members required; this will reduce social loafing and production blocking.
- Use a facilitator who knows the research about what brainstorming formats work the best, and who knows how to help the group avoid production blocking and social inhibition.
- Because complex and unexpected innovations emerge from innovative groups as a whole, group rewards need to be in place.
- Allow the group to alternate work with frequent breaks, and switch constantly between group and individual activity.
- To take advantage of the increased innovation of diverse groups, compose groups with complementary skills.
- Keep in mind that group members who are low in social anxiety and who enjoy group interaction will perform better.

My final recommendation is the most important: Don't expect a rare and occasional brainstorming session to generate innovation. Brainstorming works best in an organization that enjoys a culture of innovation, an organization where brainstorm meetings are held so often that they're just a part of doing business. In IDEO's culture of frequent brainstorming, each year everyone attends many sessions composed of crosscutting groups of people; and the sessions are places where tacit knowledge is exchanged and developed, with combinations being made between different knowledge and project experiences. Group genius can't be bottled; it has to be spread throughout the organization and practiced every day.

After these first four chapters, you might be thinking that sure, collaboration helps, but the individual brain is the ultimate source of creativity. After all, aren't people more creative when they're alone? Many of us are familiar with stories about famous painters who paint alone in the studio—such as Jackson Pollock, who left the Manhattan art scene to paint in a barn out in the country. And although you've read my account of how the mountain bike emerged from invisible collaboration, you might still be thinking that one person is responsible for each new idea. For example, doesn't Russ Mahon of the Morrow Dirt Club get credit for the idea of putting gear shifters on those old bikes? Can collaboration really explain where creative ideas come from? The "Aha" moment, the flash of insight—that seems deeply solitary and individual. And if that's where creativity lies, then studying collaboration can touch on creativity only at the edges.

It's true that the individual mind plays a special role at the center of the creative process. But your own mind is more social than you realize. In the next three chapters I'll show the surprising connection between creative insight and group genius.